PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF HIGHER EDUCATION
AND SCIENTIFIC RESEARCH

HARMONIZATION

MASTER'S DEGREE PROGRAM

ACADEMIC

Institution	Faculty / Institute	Department
Djilali Bounaama Khemis-Miliana University	Faculty of Science and Technology	Materials Sciences

Field: Materials Science

Branch : Physics

Specialization: Applied Physics

Academic Year: 2022/2023

SUMMARY

I – Master's Program Profile

(All fields must be completed)

1 - Program Location:

- **Faculty (or Institute):** Faculty of Science and Technology
- **Department:** Materials Sciences

2 - Program Partners *:**

Academic Partners:

- Ferhat Abbas University Setif 1 (UFAS1)

Research Institutions:

- Research Center in Astronomy, Astrophysics, and Geophysics (CRAAG)

Industry & Socio-Economic Partners:

International Partners:

3 – Program Context and Objectives

A – Admission Requirements *(Indicate eligible Bachelor's degrees for Master's access)*

Eligible Bachelor's degrees (subject to application review):

- **Physics (all specializations)**

B – Program Objectives

(Targeted competencies and pedagogical outcomes – max 20 lines)
The **Master's in Applied Physics** at UDBKM offers a modernized physics education with expanded career prospects. Aligned with current trends in physics, this program provides a rigorous alternative for Materials Science students seeking a curriculum that integrates theory and experimentation. Students will gain exposure to cutting-edge technologies and methodologies in instrumentation, programming, and scientific data analysis/interpretation, equipping them to address real-world challenges through hands-on methodologies rooted in physics traditions. The program emphasizes experimental practice to explore, understand, and master physical phenomena for applications in socio-economic contexts. Potential focus areas include:

- Sensor-based intelligent systems and measurement tools
- Innovative materials
- Renewable energy
- Data Science

C – Targeted Career Profiles and Competencies *(Professional integration – max 20 lines)*

This specialization trains professionals in **Applied Physics** (e.g., R&D engineers, study leads) capable of innovation in both industrial and educational settings. The curriculum covers:

- Applied mathematics
- Advanced computing, programming, and simulation
- Experimental setups and physical measurements

Key competencies:

- Autonomous work, synthesis, and presentation skills
- Data acquisition, analysis, and interpretation using custom and industry-standard physics software/tools

D – Regional and National Employability Potential

The Ain Defla region (including Khemis Miliana) is rich in agricultural and mineral resources (water, minerals). Applied Physics graduates will contribute to:

- Developing **advanced technological platforms** for data management and acquisition.
- Implementing **open-source instrumentation** and data analysis tools.
- Modernizing physics education to enhance graduates' integration into local, national, or international socio-economic ecosystems.

E – Pathways to Other Specializations

Graduates may transition to:

- Master's in **Materials Physics**
- Master's in **Energy Physics**
- Master's in **Computational Physics**
- Master's in **Instrumentation (Electronics)**

F – Program Monitoring Indicators

An evaluation system will be implemented based on the following metrics:

- **Graduation rate**
- **Enrollment numbers** (Master's level)
- **Graduate employment/placement** (Universities, Research Centers, Industrial & Economic Sectors)
- **Students progressing to PhD programs**
- **Students awarded international scholarships**
- **Students admitted to competitive national/international graduate schools**

G – Supervision Capacity

(Indicate the maximum number of students that can be accommodated)

"20 students"

4 – Available Human Resources
A: Faculty Members Participating in the Program

Name	Undergraduate Degree + Specialization	Graduate Degree + Specialization	Rank	Teaching Role*
BENTRIDI Salah-Eddine	DES in Radiation Physics	PhD in Physics	MCB	Lectures, Tutorials, Thesis Supervision
BENZAID Djelloul	DES in Radiation Physics	PhD + HDR in Physics	MCA	Lectures, Tutorials, Thesis Supervision
BITAM Tariq	DES in Radiation Physics	PhD in Physics	MCB	Lectures, Tutorials, Thesis Supervision
BOUDJEMAA Fatiha	DES in Radiation Physics	PhD in Physics	MCB	Lectures, Tutorials, Thesis Supervision
BOUKABCHA Hocine	DES in Radiation Physics	PhD + HDR in Physics	MCA	Lectures, Tutorials, Thesis Supervision
DOUCHA Missoum	DES in Energy Physics	Magister in Physics	MAA	Lectures, Tutorials, Thesis Supervision
DOUICI Mohamed	DES in Radiation Physics	PhD in Physics	MCB	Lectures, Tutorials, Thesis Supervision
ELBAA Mohamed	DES in Solid-State Physics	PhD in Physics	MCB	Lectures, Tutorials, Thesis Supervision
FERMOUS Rachid	DES in Radiation Physics	PhD in Physics	MCB	Lectures, Tutorials, Thesis Supervision
GHEDAOUIA Keltoum	DES in Radiation Physics	PhD in Physics	MCB	Lectures, Tutorials, Thesis Supervision
KOUIDER AKIL Souad	DES in Solid-State Physics	PhD in Physics	MCB	Lectures, Tutorials, Thesis Supervision

Name	Undergraduate Degree + Specialization	Graduate Degree + Specialization	Rank	Teaching Role*
MAZOUZ Amel	DES in Radiation Physics	PhD in Physics	MCB	Lectures, Tutorials, Thesis Supervision
MODERRES Mourad	DES in Energy Physics	PhD in Physics	MCB	Lectures, Tutorials, Thesis Supervision
OUERDANE Abdallah	DES in Applied Physics	PhD + HDR in Physics	Prof	Lectures, Tutorials, Thesis Supervision
OULD ARAB Halima	DES in Solid-State Physics	Magister in Physics	MAA	Lectures, Tutorials, Thesis Supervision
YEZLI Mohamed	Engineering Degree in Electronics	PhD in Physics	MCB	Lectures, Tutorials, Thesis Supervision
ZAOUI Sanaa	DES in Radiation Physics	PhD in Physics	MCB	Lectures, Tutorials, Thesis Supervision

* **Teaching Roles:** Lectures, Tutorials, Practicals, Internship Supervision, Thesis Supervision, Other (specify)

B: External Supervision

Affiliated Institution:

Research Center in Astronomy, Astrophysics, and Geophysics (CRAAG)

Name	Undergraduate Degree + Specialization	Graduate Degree + Specialization	Rank	Teaching Role*	Signature
NAITAMOR Samir	DES in Radiation Physics	PhD + HDR in Physics	D.R	Lectures, Tutorials, Practicals, Supervision (Internships & Theses)	
FOUKA Mourad	DES in Radiation Physics	PhD + HDR in Physics	M.R.A	Lectures, Tutorials, Practicals, Supervision (Internships & Theses)	

* **Teaching Roles:** Lectures, Tutorials, Practicals, Internship Supervision, Thesis Supervision, Other (specify)

5 – Moyens matériels spécifiques disponibles

A - Teaching Laboratories and Equipment: Existing Instructional Equipment for Practical Work in the Proposed Program *(One form per laboratory)*

Laboratory Name: Electricity & Electronics

Student Capacity: 20

	Equipment Description	Quantity	Notes
01	20MHz Oscilloscope	07	Digital
02	35MHz Oscilloscope	08	Analog
03	Frequency Generator	04	N/A
04	Ammeter (10A)	12	Analog needle
05	Voltmeter (300V)	11	Analog needle
06	Multimeter	01	Analog needle
07	Slider Rheostat	02	-
08	Resistance Box	03	-
09	Decade Resistance Box	02	-
10	Variable Turn Coils	01	-
11	RLC Circuit	04	-
12	Starter Coil	01	With chronometer PC
13	Coil Set	01	-
14	Switch	04	-
15	Motor-Generator System	02	-
16	Laplace Apparatus	01	-
17	Electricity Experiment Kits	02	-
18	Multimeter	03	Digital
19	Coils	04	-
20	Function Generator	05	-
21	Potentiometer Set	10	-
22	Decade Resistance Box	10	-
23	Slider Rheostat Set	05	-
24	Decade Inductance Box	05	-
25	12V Power Supply	08	-
26	Multimeter	04	Digital
27	Basic Connection Accessories	50	-
28	BNC Connectors	60	-
29	Connectors	-	-
30	DC Power Supply	04	-
31	Electricity Experiment Kit	01	PHYWE brand

Laboratory Name: Vibrations and Waves

Student Capacity: 20

	Equipment Description	Quantity	Notes
01	MELD Apparatus	03	Wave propagation in strings
02	Kundt's Tube	02	Sound velocity measurement
03	RLC Circuit	05	Oscillation analogy
04	Spring	05	--
05	Support Stand	05	--
06	Loudspeaker	02	--
07	Frequency Generator	02	--
08	Connection Accessories	20	--

Laboratory Name: Applied Electronics (Received in 2015)

Student Capacity: 20

	Equipment Description	Quantity	Notes
01	Digital Electronics Lab: IDL-800A	01	With accessories
02	PC-Controlled Sensor Kit: KL-600	01	With accessories
03	Biomedical Data Acquisition System: KL-710	01	With accessories
04	Modulation and Coding Test Bench: MCM21/EV PSLC/EV	01	With accessories
05	Amplifiers and Oscillators Test Bench: KL-200	01	With accessories
06	Basic Communication Training System: KL-900A	02	With accessories
07	Mobile Phone Communication System: EB-115	01	--
08	Antenna Test Bench: WL-AMS-A	01	--
09	Antenna Test Bench: WL-AMS-B	01	--
10	Microwave Electronics Test Bench: MW-E/EV	01	With accessories
11	Microwave Techniques Test Bench with MTB	01	With accessories
12	Optical Fiber Transmission Test Bench: KL-900D	01	With accessories
13	Electromagnetic Field Tester: ES/24	01	--

Laboratory Name: Modern and Applied Physics (Pending Delivery)

Student Capacity: 20

#	Equipment Description	Qty	Technical Specifications
01	Electric Field in Parallel Plate Capacitor	01	Measures electric field using field meter
02	Coulomb's Law Apparatus	01	Verifies inverse square law ($F \propto 1/R^2$), Force/Charge relationship, Determines Coulomb's constant
03	Faraday's Law Demonstrator	01	Energy conservation, Magnetic flux, Faraday's/Lenz's laws of induction
04	Magnetic Force in Current-Carrying Wires	01	--
05	Magnetic Field in Coil Pair System	01	Single coil field, Helmholtz coil field, Solenoid field
06	Earth's Magnetic Field Analyzer	02	Measures magnitude/direction of geomagnetic field, Dip angle
07	Electron Spin Resonance (ESR) System	01	With accessories
08	Ferromagnetic Hysteresis Demonstrator	01	With accessories
09	Hall Effect Experiment Kit	01	With accessories
10	Franck-Hertz Experiment: Mercury Spectrum	01	With accessories
11	X-Ray Physics Apparatus	01	With accessories
12	Franck-Hertz Experiment: Neon Spectrum	01	With accessories
13	Atomic Spectrum Analyzer	01	With accessories
14	Magnetic Levitation System	01	With accessories
15	Multifunction Vibrometer	03	With accessories

Laboratory Name: Faculty Computer Rooms

Number of Rooms: 08

Student Capacity: 20

#	Equipment Description	Quantity	Notes
01	Desktop Computer	10	--

B- Internship Sites and Industry Training:

Internship Location	Number of Students	Duration

C- Research Laboratories Supporting the Master's Program:

Laboratory Director: MAHIEDDINE Ali
Laboratory Accreditation Number **Laboratory Name:** Energy and Intelligent Systems Laboratory
Date: Laboratory Director's Comments:

D- Research Projects Supporting the Master's Program:

Research Project Title	Project Code	Start Date	End Date
Modeling, Simulation and Instrumentation for Healthcare Applications	B00L02UN440120220002	01/01/2022	31/12/2025

E- Personal Workspaces and ICT Facilities:

- Internet-equipped computer rooms
- Faculty of Science and Technology Library
- Department of Materials Science Laboratories
- Dedicated Master's Student Rooms
- Department of Materials Science Computer Laboratory

II - Semester-Based Teaching Organization

(Please complete forms for all 4 semesters)

1 - Semester 1

Education Units (EU)	SHV	Weekly Contact Hours (WCH)				Coeff	Credits	Assessment Method	
	14-16 week	Course	TD	TP	Others			Continuous	Final exam
Fondamental EU						**09**	**18**		
UEF 11(O/P)									
Advanced Electromagnetism	45h00	01h30	01h30			02	04	33%	67%
Physical Optics	45h00	01h30	01h30			02	04	33%	67%
UEF 12(O/P)									
Solid State Physics	67h30	03h00	01h30			03	06	33%	67%
Advanced Fluid Mechanics	45h00	01h30	01h30			02	04	33%	67%
Methodology EU						**05**	**09**		
UEM 11(O/P)									
Signal Processing	45h00	01h30	01h30			01	02	50%	50%
Scientific Programming I	45h00			03h00		02	03	100%	
UEM 12(O/P)									
Workshop I: Electronic Circuits	45h00			03h00		02	04	100%	
Discovery EU						**01**	**01**		
UED 11(O/P)									
Measurements & Uncertainties	22h30	01h30				01	01		100%
Transversal EU						**02**	**02**		
UET 11(O/P)									
Scientific Writing & Analysis	45h00			03h00		02	02	100%	
Total Semester 1	405h00	10h30	07h30	09h00		**17**	**30**		

2- Semester 2

Education Units (EU)	SHV	Weekly Contact Hours (WCH)				Coeff	Credits	Assessment Method	
	14-16 week	Course	TD	TP	Others			Continuous	Final exam
Fondamental EU						**09**	**18**		
UEF 21(O/P)									
Advanced Semiconductor Physics	45h00	01h30	01h30			02	04	33%	67%
Physical Properties of Materials	67h30	03h00	01h30			03	06	33%	67%
UEF 22(O/P)									
Matter-Radiation Interactions	45h00	01h30	01h30			02	04	33%	67%
Heat Transfer	45h00	01h30	01h30			02	04	33%	67%
Methodology EU						**05**	**09**		
UEM 21(O/P)									
Materials Characterization & Analysis	45h00	01h30	01h30			01	02	50%	50%
Scientific Programming II	45h00			03h00		02	03	100%	
UEM 22(O/P)									
Workshop II: Electronic Development Boards	45h00			03h00		02	04	100%	
Discovery EU						**01**	**01**		
UED 21(O/P)									
Quantum Computing	22h30	01h30				01	01		100%
Transversal EU						**02**	**02**		
UET 21(O/P)									
Renewable Energies	45h00	01h30	01h30			02	02	50%	50%
Total Semester 2	405h00	12h00	09h00	06h00		**17**	**30**		

3- Semester 3

Education Units (EU)	SHV	Weekly Contact Hours (WCH)				Coeff	Credits	Assessment Method	
	14-16 week	Course	TD	TP	Others			Continuous	Final exam
Fondamental EU						**09**	**18**		
UEF 31(O/P)									
Nanotechnologies	45h00	01h30	01h30			02	04	33%	67%
Dielectric & Magnetic Materials	45h00	01h30	01h30			02	04	33%	67%
UEF 32(O/P)									
Energy Materials	45h00	01h30	01h30			02	04	33%	67%
Heat Exchanger Systems	67h30	03h00	01h30			03	06	33%	67%
Methodology EU						**05**	**09**		
UEM 31(O/P)									
Advanced Rheology	45h00	01h30	01h30			01	02	50%	50%
Scientific Data Processing & Analysis	45h00			03h00		02	03	100%	
UEM 32(O/P)									
Workshop III: Physical Signal Acquisition & Measurement	45h00			03h00		02	04	100%	
Discovery EU						**01**	**01**		
UED 31(O/P)									
Management	22h30	01h30				01	01		100%
Transversal EU									
UET 31(O/P)									
Scientific Communication	45h00			03h00		02	02	100%	
Total Semester 3	405h00	10h30	07h30	09h00		17	**30**		

4 - Semester 4

Field: Matter Sciences
Brach: Physics
Specialization: Applied Physics

Supervised industrial internship assessed through a written thesis and oral defense examination

Component	**Semestre Contact Hours**	**Coeff**	**Credits**
Independent Research	420	20	20
Industry Placement	160	08	08
Professional Seminars	20	02	02
Others			
Total	**600**	**30**	**30** (25%)

5 - Degree Program Overview*(Instructional hours across 3 academic semesters)*

EU / Contact hours	**FEU**	**MEU**	**DEU**	**TEU**	**Totals**
Courses	337h30	67h30	67h30	22h30	495h00
Tutorials (TD)	270	67h30		22h30	360h00
Laboratory	-	270h00		90h00	360h00
Independent Research					
Others					
Totals	**607h30**	**405h00**	**67h30**	**135h00**	**1215h00**
Credits	54	27	03	06	**90**
% in credits for each EU	60%	30%	3.03%	6.06%	100%

III - Detailed Course Descriptions

(One comprehensive syllabus sheet per course)

Master's Tiltle: Applied Physics
Semester: 1
Course Unit (UE): UEF11
Course Title: Advanced Electromagnetism
Credits (ECTS): 4
Weighting Coefficient: 2

Course Objectives

This course enables physics graduates to:

- Build upon foundational EM knowledge from undergraduate studies
- Master advanced theoretical concepts in electromagnetism
- Develop applied skills for modern EM technologies

Prerequisite Knowledge:

- Vector calculus (div, grad, curl operators), Fundamentals of electromagnetism

Course Content

1. Maxwell’s Equations
2. EM Potentials & Energy
3. Electric/Magnetic Dipoles
4. EM Waves in Vacuum
5. Wave Reflection/Refraction
6. Anisotropic Media Propagation
7. Waveguides & Cavities

Evaluated method: ………. Continuous : 33% and Final Examination : 67%

References

1. Fitzpatrick R., Maxwell’s Equations and the principles of Electromagnetism, 2008, Jones & Bartlett Edition
2. Pramanik A., 2009, Electromagnetism – Theory & Applications, PHI Learning Pvt. Ltd
3. Feynman R. P & al. 2011, The Feynman Lectures on Physics, Vol II, Ed. Basic Books
4. Kraus J. D., Fleisch D. A, 1973, Electromagnetics with Applications, Ed. William C Brown Pub
5. Ulaby F. T., Ravaoili U., 2014, Fundamentals of Applied Electromagnetics, Ed. Prentice Hall

Master's Title: Applied Physics
Semester: 1
Course Unit (UE): UEF12
Course Title: Physical Optics
Credits: 04
Coefficient: 02

Course Objectives

This course equips students to:

- Analyze the origin of geomagnetic field anomalies
- Determine relevant geomagnetic field components for data acquisition, processing, and interpretation
- Apply optical principles to solve practical problems in either:
  - **Research contexts** (e.g., instrumentation development)
  - **Exploration applications** (e.g., remote sensing)

Prerequisite Knowledge: Electromagnetism, Basic Geometrical Optics

Course Content

1. Geometrical Optics Review
2. EM Waves & Spectra
3. Light Reflection/Refraction
4. Interference & Diffraction
5. Optical Instruments
6. Aberrations
7. Dispersion Phenomena
8. Radiometry & Photometry
9. Optical Communication

Evaluated method: ………………..continuous and Final examination…………..

References:

1. Rolt, S. 2020, Optical Engineering Science, Wiley Ed.

2. Pandey, DC. 2014, Optics and Modern Physics, Ed. ARIHANT

Master's Title: Applied Physics
Semester: 1
Course Unit (UE): UEF11
Course Title: Solid State Physics
Credits: 6
Coefficient: 3

Course Objectives

Upon completion, students will be able to:

- **Explain** crystal cohesion principles and discrete symmetries in real/reciprocal space, including their conservation law implications
- **Solve** problems in insulating, semiconducting, and metallic materials
- **Apply** quantum mechanics and statistical physics tools to analyze macroscopic solid properties
- **Validate** theoretical hypotheses through experimental data comparison
- **Describe** solid-state phenomena in clear technical terms

Prerequisites: Solid State Physics I & II (Undergraduate Materials Science)

Course Content

I. Crystalline Symmetry Consequences: Brillouin zone theory (general/reduced), Energy symmetry and effective mass, Density of states calculations

II. Electronic Structure & Electron Propagation: Born-Oppenheimer approximation, Fermi-Dirac distribution, Energy band formation (Bloch theorem), Quasi-free electron model, Semiconductor crystals: Electron-hole pairs, Impurity conductivity.

III. Electron Dynamics in Crystals: Semiclassical approximation, Boltzmann equation (steady-state solutions), Relaxation time approximation, Transport phenomena: Electrical/thermal conductivity, Thermoelectric effects, Hall effect, Magnetoresistance (metals/semiconductors)

Assessment Structure: ……..continuous: 33% and Final examination: 67%

References:

1. Physique des solides, N.W. Ashcroft, N.D Mermin, traduit par F. Biet, H. Kachkachi, EDP Sciences, 2002

2. Introduction to solid state physics, C. Kittel, 5th , Wiley .1983.

3. H.E Hall, Solid state physics, Wiley ELBS ed ,1979

4. Physique des matériaux, Yves Quéré, ellipses, 1988

Master's Title: Applied Physics
Semester: 1
Course Unit (UE): UEF12
Course Title: Advanced Fluid Mechanics
Credits: 4
Coefficient: 2

Course Objectives: To provide students with more in-depth knowledge of fluid mechanics.
Recommended Prerequisite Knowledge: Basic concepts in fluid mechanics**.**

Course Content

1. Review of fluid mechanics
   a. Tensor calculus
   b. Fluid kinematics
   c. Stress tensor
   d. Strain rate tensor
   e. Navier-Stokes equations
2. Rotational and steady planar flows of a perfect incompressible fluid
   a. Complex potential
   b. Force calculation
3. Dynamics of viscous fluids
   a. Integral equation of motion
   b. Local equation
   c. Solving some classic unsteady problems
4. Dimensional analysis
   a. Similarity and dimensional analysis
   b. Applications
5. Exact solutions of the Navier-Stokes equations
   a. Exact solutions
   b. Approximate solutions
6. Boundary layer theory
   a. Laminar boundary layer
   b. Prandtl's theory
   c. Exact (affine) solutions
   d. Approximate solutions (global methods)

Evaluated method: Continuous : 40% ; Final Examination : 60%

Reference Materials

1. Schlichting, H., & Gersten, K. (2003). *Boundary-layer theory*. Springer Science & Business Media.
2. Cousteix, J. (1997) Aérodynamique-Couche Limite Laminaire.
3. Comolet, R. (2002) *Mécanique Expérimentale des Fluides*. Tome 1,2 et 3, Ed. Dunod, Paris.
4. Zeytounian, R. K. (2008). *Mécanique des fluides fondamentale* (Vol. 4). Springer.
5. Luneau, J. (1975) , *Dynamique Des Fluides Compressibles*, Cepadues Éditions.
7. Salençon, J. (2005). *Mécanique des milieux continus: Concepts généraux* (Vol. 1).

Editions Ecole Polytechnique.

Master's Title: Applied Physics

Semester: 01

Module Title: UEM11

Course Title: Signal Processing

Credits: 02

Coefficient: 01

Course Objectives:

To acquire basic concepts in signal processing and random processes.

Recommended Prerequisite Knowledge:

Physics and Mathematics

Program Content:

Chapter 1: Generalities on Signals

Analog/discrete signals, Specific signals, Deterministic and random signals, Notions of power and energy.

Chapter 2: Fourier Analysis

Introduction, Fourier series, Fourier transform, Parseval's theorem.

Chapter 3: Laplace Transform

Properties of the Laplace transform, Time and frequency domain analysis.

Chapter 4: Convolution Product

Formulation of the convolution product, Properties of the convolution product, Convolution product and Dirac impulse, Deconvolution.

Chapter 5: Signal Correlation

Cross-correlation between signals, Autocorrelation, Properties of the correlation function, Case of periodic signals.

Chapter 6: Sampling and Discrete Signals

Discrete signals, Real sampling, Ideal sampling, Sampling theorem, Z-transform.

Evaluation Method: Continuous assessment and final exam

References:

1. S. Haykin, *Signals and Systems*, John Wiley & Sons, 2nd edition, 2003.
2. A.V. Oppenheim, *Signals and Systems*, Prentice–Hall, 2004.
3. J. Max, *Traitement du signal*.

Master's Title: Applied Physics
Semester: 01
Module Title: UEM11
Course Title: Scientific Programming 1
Credits: 03
Coefficient: 02
Course Objectives:
To acquire the necessary skills to use a computer to simulate physical models through specialized tools that students will learn to master, in order to obtain robust numerical predictions.
Recommended Prerequisite Knowledge:
Basic computer skills, knowledge of algorithms and programming acquired during the L1 SM level.
Course Content: In-person
Choose from: Python, R language, Go, C++, …
a. Language
b. Command interpreter
c. The concept of variables
d. Input and output
e. Conditions and loops
f. Modules and functions
g. Lists and strings
h. Files
i. Downloading, installing, launching, and exploring the working environment
j. Basic calculations
k. Variables, saving and loading data
l. Arrays, vectors, and matrices
m. Graph plotting
n. Creation and execution of script files
o. Control statements
p. Functions
Evaluation Method: Continuous assessment
References:

1. User manuals for Python, Scilab, SageMath, and LabView.
2. Pons, Nicolas. *Linux: Principes de base de l'utilisation du système*. Saint-Herblain: Éditions ENI, 2013.
3. Ouin, José. *Algorithme & calcul numérique: Travaux pratiques résolus, programmation avec les logiciels Scilab et Python*. Paris: Ellipses, 2013.
4. Audibert, Thierry; Oussalah, Amar. *Informatique: Programmation et calcul scientifique en Python et Scilab*. Paris: Ellipses, 2013.

Master's Title: Applied Physics

Semester: 01

Module Title: UEM12

Course Title: Workshop 1: Electronic Circuits

Credits: 04

Coefficient: 02

Course Objectives:

The student is required to build various types of electronic circuits in order to become familiar with the experimental and applied aspects of the training and to prepare for the development of more complex systems.

Recommended Prerequisite Knowledge:

Electricity, Electronics

Course Content:

- DC Electrical Circuits
- RLC Circuits with Alternating Current
- Voltage Divider Circuit
- Diode Circuits (Rectifier)
- Transistor Circuits
- Operational Amplifier
- Multi-stage Circuits

Evaluation Method: Continuous assessment

References:

- Rikard Blunck, Louis-André Hamel, and Jean-Yves Lapointe, 2011, *Introduction à la Physique Expérimentale*, Educational Handout, Université de Montréal.

Master's Title: Applied Physics

Semester: 01

Module Title: UED11

Course Title: Measurements and Uncertainties

Credits: 01

Coefficient: 01

Course Objectives:

This course will allow the student to recall the essential foundations of experimental physics: the quantification and qualification of physical measurements.

Recommended Prerequisite Knowledge:

Electronics, Physics 1

Course Content:

1. Review of physical measurement
2. Uncertainty calculation for a measurement
3. Modeling and determination of parameters

Evaluation Method:

Exam

References:

Master's Title: Applied Physics

Semester: 01

Module Title: UET11

Course Title: Scientific Text Analysis and Writing

Credits: 02

Coefficient: 02

Course Objectives:

This scientific writing and text analysis exercise aims to teach students the basic rules and methods for writing a scientific text—whether a report, an article, or a thesis—based on synthesized ideas from reading scientific documents.

Recommended Prerequisite Knowledge:

French

Scientific and technical terminology

Course Content:

1. Placement test: writing a scientific paragraph and statistical text analysis
2. Rules of scientific writing
3. Gathering material for scientific writing
4. Scientific text analysis: main idea, secondary idea, quantitative and descriptive information, keywords
5. Applications

Evaluation Method: Continuous assessment

References:

- *Manuel de Rédaction Scientifique et Technique*, Prof. Charles-François Boudouresque

Master's Title: Applied Physics
Semester: 02
Course Unit Title: UEF21
Course Title: Semiconductor Physics
Credits: 04
Coefficient: 02
Course Objectives:
In this course, after defining what a semiconductor material is, we will study its physical properties by comparing them with those of other materials (metals, insulators). Junctions and contacts will be explained, with a focus on improving the properties of semiconductors through doping (n-type and p-type). The concept of energies (energy bands, band gaps), band curvature, and band tails will also be clearly defined.
Recommended Prerequisites: Solid State Physics
Course Content:
I. Generalities
II. Some Properties
III. Undoped and Doped Semiconductors
IV. Semiconductors at Equilibrium
V. Poisson's Equation and Consequences
VI. Small Perturbations from Equilibrium
VII. Large Perturbations from Equilibrium
VIII. Evolution Equations
IX. Contact Between Two Different Semiconductor Materials
X. Energy Band Diagrams of Semiconductors
Evaluation Method: Continuous assessment + final exam
References:

1. *Physique des semi-conducteurs et des composants électroniques*, H. Mathieu
2. *Propriétés électroniques*, M. Brousseau

Master’s Title: Applied Physics

Semester: 02

Course Unit Title: UEF21

Course Title: Physical Properties of Materials

Credits: 06

Coefficient: 03

Course Objectives:

To provide students with a fundamental understanding of the various physical properties of materials for scientific or industrial applications. This knowledge will help learners understand the context of material use and the selection criteria for specific applications.

Recommended Prerequisites:

- Knowledge of Solid State Physics

Course Content:

1. Material Structure
2. Mechanical Properties
3. Electrical Properties
4. Thermal Properties
5. Optical Properties

Evaluation Method: Continuous assessment (33%) and final exam (67%)

References:

1. Lovell M.C. et al., *Physical Properties of Materials*, Springer Netherlands, 1976
2. White M. A., *Physical Properties of Materials*, CRC Press, 2011

Master’s Title: Applied Physics

Semester: 02
Course Unit Title: UEF22
Course Title: Radiation-Matter Interaction
Credits: 04
Coefficient: 02

Course Objectives:
To enable the student to characterize materials by inducing excitation (via X-rays, IR, neutrons, electrons, etc.) and to understand the limitations of each experimental technique.
Recommended Prerequisites: Basic knowledge of wave phenomena (interference) and the particle nature of matter

Course Content:
Chapter I: Fundamental Concepts in Radiation-Matter Interactions
1. Conservation Laws in Interactions
2. Cross Section
3. Mean Free Path

Chapter II: Photon-Matter Interaction
1. Main Processes
2. Application to X-rays

Chapter III: Electron-Matter Interaction
1. Energy Loss by Ionization
2. Energy Loss by Bremsstrahlung
3. Linear Energy Transfer (LET)
4. Range
5. High-Energy Electron Interactions

Chapter IV: Interaction of Heavy Charged Particles with Matter
1. Passage of Heavy Charged Particles through Matter
2. Ionization by Heavy Charged Particles
3. Interaction with Condensed Matter

Evaluation Method: Continuous assessment and final exam

References:

1. Ellipses Marketing, *Ondes et matière*, 2007
2. Y. Arnoud, *Interaction rayonnement matière*
3. Daniel Blanc, *Les rayonnements ionisants*, Masson, 1990–1997
4. J. Michel Hollas, *Spectroscopie*, Dunod, 1998
5. Sekkal Zohir, *Atomes et liaisons chimiques*, OPU, 1988
6. Kadi-Hanafi Mouhyddine, *Électricité, Rayonnement et Radioactivité*, OPU, 1982
7. Pierre Chevalier, *Interaction du rayonnement avec la matière*, Techniques de l’Ingénieur

Master’s Title: Applied Physics

Semester: 02

Course Unit Title: UEF22

Course Title: Heat Transfer

Credits: 04

Coefficient: 02

Course Objectives:

To master the fundamentals of the three modes of heat transfer. To learn how to write a heat balance and construct a basic model.

Recommended Prerequisites:

Mathematics and physics or mechanics training, applied thermodynamics knowledge

Course Content:

Chapter 1: Conduction

Chapter 2: Radiative Heat Transfer

Chapter 3: Convection

Chapter 4: Heat Transfer During Phase Changes

Chapter 5: Mass Transfer

Evaluation Method: Continuous assessment and final exam

References:

1. Carslaw, H. S. & Jaeger, J. C., *Conduction of Heat in Solids*, 2nd ed., Clarendon, 1959
2. Ozisik, M. N., *Conduction Heat Transfer*, Wiley, 1980
3. Gebhart, *Heat Transfer*, McGraw Hill, 1971
4. Bejan & Kraus, *Heat Transfer Handbook*, Wiley, 2003
5. Kreith & Boehm et al., *Heat and Mass Transfer*, CRC Press, 1999

Master’s Title: Applied Physics

Semester: 02

Course Unit Title: UEM21

Course Title: Materials Characterization and Analysis

Credits: 02

Coefficient: 01

Course Objectives:

To learn the characterization techniques of materials in order to analyze and identify them.

Recommended Prerequisites:

Solid State Physics

Course Content (In-Person):

1. Conductivity Measurement
2. Four-Point Probe Measurement
3. Carrier Lifetime Measurement
4. Spectral Response (Photoconductivity)
5. Hall Effect
6. Auger Spectroscopy

Evaluation Method: Continuous assessment and final exam

References:

1. Hing T. Diep, *Physique de la matière condensée*
2. Yuri M. Galperin, *Introduction to Modern Solid State Physics*
3. P. M. Chaikin, *Principles of Condensed Matter Physics*
4. Charles Kittel, *Introduction to Solid State Physics*
5. Henry Mathieu, *Physique des semi-conducteurs et des composants électroniques*

Master’s Title: Applied Physics

Semester: 02

Course Unit Title: UEM21

Course Title: Scientific Programming 2

Credits: 03

Coefficient: 02

Course Objectives:

Computer programming applied to physics allows proposing models that are adapted to experiments. The material growth obtained by physical methods is explained using these models, which are developed through programming. The student is expected to create an interface between physical laws and computing.

Recommended Prerequisites:

- Programming skills

Course Content:

- Review of programming in advanced language (Python)
- Matplotlib
- Numpy
- Pandas
- Scipy
- Applications in Physics

Evaluation Method: Continuous assessment

References:

Master's Title: Applied Physics

Semester: 02

Course Unit Title: UEM22

Course Title: Workshop 2: Electronic Development Boards

Credits: 04

Coefficient: 02

Course Objectives:

In this workshop, students will become familiar with electronic development boards such as Arduino, Raspberry Pi, or similar.

Recommended Prerequisites:

Electronics, basic programming knowledge

Course Content:

- Introduction to Arduino
- Introduction to Raspberry Pi

Evaluation Method: Continuous assessment

References:

- https://docs.arduino.cc
- Savasgard E., *Arduino for Beginners*, 2016
- Wilcher D., *Make: Basic Arduino Projects*, Maker Media, 2014
- *The Official Raspberry Pi Projects Book*, The MagPi, 2016

Master’s Title: Applied Physics

Semester: 02
Course Unit Title: UED21
Course Title: Quantum Computing
Credits: 01
Coefficient: 01

Course Objectives: The aim of this course is to introduce students to quantum computing and to familiarize them with this emerging trend in computing and new information technologies.

Recommended Prerequisites: Algorithms, Computer Science, Basic Quantum Mechanics.

Course Content:
Chapter 1: Quantum Bits

1. What is a qubit?
    - Classical bit vs. quantum bit
    - Physical implementation of a qubit
2. Qubits and Quantum Postulates
    - State postulate
    - Observable quantities postulate
    - Measurement postulate

Chapter 2: Quantum Entanglement
2. Two-qubit states
3. Manipulation of two-qubit states
4. Application: Quantum Teleportation
Chapter 3: Physical Implementations
3.1. Nuclear Magnetic Resonance
3.2. Trapped Ions
3.3. Solid-State Qubits

Evaluation Method: 100% Final Exam

References:

1. Michel Le Bellac, *Introduction à l’information quantique*, Hal Open Science, 2006
2. David Deutsch & Richard Jozsa, “Rapid solutions of problems by quantum computation,” *Proceedings of the Royal Society of London A*, vol. 439, 1992
3. David Deutsch, “Quantum theory, the Church-Turing principle and the universal quantum computer,” *Proceedings of the Royal Society of London A*, vol. 400, 1985

Master’s Title: Applied Physics

Semester: 02

Course Unit Title: UET21

Course Title: Renewable Energies

Credits: 02

Coefficient: 02

Course Objectives:

One of the major challenges facing humanity’s future is pollution, water, and energy. The latter two are considered the cornerstone of any civilization. This course is presented in that context to students of the Master's program.

Recommended Prerequisites:

Heat Transfer, Electromagnetism, Thermodynamics

Course Content:

1. Energy Worldwide
2. Solar Energy
3. Wind Energy
4. Hydropower
5. Geothermal Energy
6. Fuel Cells
7. Nuclear Fusion

Evaluation Method: Final Exam

References:

1. G. Boyle, *Renewable Energy*, 2nd ed., Oxford, 2004
2. A. V. Da Rosa, *Fundamentals of Renewable Energy Processes*, Elsevier, 2005
3. B. Sorenson, *Renewable Energy Conversion, Transmission, and Storage*, Elsevier, 2008
4. B. Wu, N. Zargari, S. Kouro, *Power Conversion and Control of Wind Energy Systems*, Wiley, 2011

Master Title: Applied Physics

Semester: 03

Course Unit Title (UE): UEF31

Course Title: Nanotechnologies

Credits: 04

Coefficient: 02

Course Objectives

The student will discover the world of nanotechnology and the science of nanomaterials as well as their applications in various fields, particularly medical and industrial.

Recommended Prerequisites

Solid State Physics, Electromagnetism.

Course Content

1. History of nanotechnology
2. Material size
3. Nanoparticles
4. Carbon nanostructures
5. Tools for nanotechnology
6. Nanoparticle systems
7. Medical applications

Assessment Method: Continuous assessment 33% and Final exam 67%

References

- Binns C., 2010, "Introduction to Nanoscience and Nanotechnology", Wiley Ed.

Master Title: Applied Physics

Semester: 03

Course Unit Title (UE): UEF31

Course Title: Dielectric and Magnetic Materials

Credits: 04

Coefficient: 02

Course Objective

To provide the student with a quantitative understanding of a particular type of material, ceramics, and to be able to implement components sized for selected electrical or dielectric applications.

Recommended Prerequisites

Solid State Physics, Electromagnetism.

Course Content

I. Dielectric Materials

1. Macroscopic and microscopic approaches
2. Polarization and relaxation
3. Piezoelectric materials
4. Ferroelectric materials
5. Pyroelectric materials

II. Magnetic Materials

1. Macroscopic and microscopic approaches
2. Hysteresis curve
3. Soft magnetic materials
4. Hard magnetic materials
5. Microscopic theory (paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism)
6. Magnetic resonance
7. Applications

Assessment Method: Continuous assessment (33%) & Final exam (67%)

References

1. L. Solymar & D. Walsh, *Electrical Properties of Materials*, Oxford University Press, 2003.
2. Kwan Chi Kao, *Dielectric Phenomena in Solids*, Elsevier Academic Press, 2004.

Master Title: Applied Physics

Semester: 03

Course Unit Title (UE): UEF32

Course Title: Materials for Energy

Credits: 04

Coefficient: 02

Course Objectives

To acquire general knowledge on the use of materials for energy production.

Recommended Prerequisites

Solid State Physics, Atomic and Nuclear Physics, Heat Transfer

Course Content

- Solar energy: photothermal and photovoltaic
- Energy conversion and storage: fuel cells
- Physics of materials: new materials, superconductors, nanophysics
- Hot plasmas – Fusion
- Low-temperature materials
- Cryogenics and cryophysics
- Microthermal and microfluidics

Assessment Method: Continuous assessment and Final exam

References

1. Charles Chahine & Philippe Devaux (1993), *Statistical Thermodynamics - Course Summaries and Solved Problems*, Dunod
2. Walter Greiner, Ludwig Neise, Horst Stöcker (1999), *Thermodynamics and Statistical Mechanics*, Springer

Master Title: Applied Physics

Semester: 03

Course Unit Title (UE): UEF32

Course Title: Heat Exchangers

Credits: 06

Coefficient: 03

Course Objectives

This course will introduce students to one of the crucial applications and technologies of heat transfer. It will serve as an advanced initiation for the definition, configuration, and calculation of a heat exchanger.

Recommended Prerequisites

Fluid Mechanics, Heat Transfer

Course Content

1. General description
2. Principle of a heat exchanger
3. Geometric configurations of a heat exchanger
4. Heat exchanger calculations
5. Applications

Assessment Method

Continuous assessment (33%) and Final exam (67%)

References

1. Mebarek-Oudina F., *Heat Exchangers*, Ed. EL-Djazairia
2. Padet J.P., 1997, *Heat Exchangers*, Ed. Masson
3. Bontemps A. & al., 1978, *Technology of Heat Exchangers*, Vol. I

Master Title: Applied Physics

Semester: 03

Course Unit Title (UE): UEM31

Course Title: Rheology

Credits: 02

Coefficient: 01

Course Objectives

The student will discover a more advanced branch of fluid mechanics and energetics with the necessary concepts to understand different types of fluids and their related applications.

Recommended Prerequisites

Fluid Mechanics

Course Content

Chapter 1: Basic concepts of rheology of complex fluids

Chapter 2: Flow modes and applications

Chapter 3: Viscoelasticity and application

Chapter 4: Rheometry

Chapter 5: Rheological experimentation and modeling

Assessment Method: Exam 50% and Continuous assessment 50%

References

1. *Mechanics and Rheology of Fluids in Chemical Engineering* (Midoux)
2. *Understanding Rheology* (Coussot and Grossiord)
3. *Rheophysics: Matter in All Its States* (Coussot and Guyon)
4. *Numerical Simulation of Non-Newtonian Flow* (Crochet, Davies, and Walters)
5. *Rheology of Materials and Engineering Structures* (Sobotka)
6. *An Introduction to Rheology* (Barnes, Hutton, and Walters)

Master Title: Applied Physics

Semester: 03

Course Unit Title (UE): UEM31

Course Title: Scientific Data Processing and Analysis

Credits: 03

Coefficient: 02

Course Objectives

Acquire the necessary skills to use computers to simulate, through specialized tools that students will learn to master, physical models until robust numerical predictions are obtained.

Recommended Prerequisites

Basic computer skills, algorithm and programming concepts acquired during the L1 SM level.

Course Content (in person)

1. Introduction to scientific data
2. Python for Data Science
3. Data visualization
4. Linear algebra
5. Statistics & probability with Python
6. Hypotheses and inferences
7. Gradient descent
8. Data manipulation
9. Machine Learning
10. K-nearest neighbors
11. Naive Bayes
12. Simple and multiple linear regression
13. Logistic regression
14. Decision tree
15. Neural networks

Assessment Method: Continuous assessment

References

1. Grus J., 2019, *Data Science from Scratch: First Principles with Python*, O'Reilly Media
2. Johansson R., 2019, *Numerical Python: Scientific Computing and Data Science Applications with Numpy, SciPy and Matplotlib*, Apress
3. Audibert T., Oussalah A., 2013, *Computer Science: Programming and Scientific Computing in Python and Scilab*, Ellipses

Master Title: Applied Physics

Semester: 03

Course Unit Title (UE): UEM32

Course Title: Workshop 3 – Acquisition and Measurement of Physical Signals

Credits: 04

Coefficient: 02

Course Objectives

In this methodological subject, students are required to carry out experiments and build experimental setups using development boards (ARDUINO, STEM, Raspberry…).

Recommended Prerequisites

Basic management concepts

Course Content

1. Measurement bench with temperature and humidity sensors
2. Measurement bench with proximity and ultrasonic sensors
3. Measurement bench with light and IR sensors
4. Measurement bench with pressure and flow sensors
5. Motorized bench
6. Programming of a semi-automatic bench with triggering

Assessment Method: Continuous assessment

References

1. Smith F. S., 2020, *Experimental Physics: Principles and Practice for the Laboratory*, CRC Press
2. Schwartz M. & Manickum O., 2015, *Programming Arduino with LabVIEW*, Packt Publishing
3. Karvinen T., Karvinen K., Valtokari V., 2014, *Sensors: Projects and Experiments to Measure the World with Arduino and Raspberry Pi*, Maker Media Ed.

Master Title: Applied Physics

Semester: 03

Course Unit Title (UE): UED31

Course Title: Management

Credits: 01

Coefficient: 01

Course Objectives

The course aims to instill in the learner a managerial and entrepreneurial culture.

Recommended Prerequisites

Basic management concepts

Course Content

7. Entrepreneurial profile and motivations
8. Startup ecosystem
9. From idea to market
10. From market to growth
11. Administration and management

Assessment Method: Exam

References

Blank, S. & Dorf B., 2012, *The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company*, K&S Ranch

Master Title: Applied Physics

Semester: 03

Course Unit Title (UE): UET31

Course Title: Scientific Communication

Credits: 02

Coefficient: 02

Course Objectives

In this module, previously acquired knowledge on scientific writing will be applied to communicate the content of a scientific document in a concise and practical manner.

Recommended Prerequisites

French language

Scientific and Technical Terminology

Scientific writing techniques

Course Content

- Placement test: presentation exercise
- Presentation plan
- Selection of relevant information
- Presentation of information
    - Textual presentation
    - Graphical presentation
    - Numerical presentation (tables)
- Concluding with a presentation
- Application

Assessment Method: Continuous assessment

References: